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BALLISTICS

Measurement of Angles

In marksmanship, the dilec (Czech mil) is used as the unit for the measurement of angles. This unit of measurement equals 1/6000 of the circle.

The length of the part of the circle's circumference which corresponds to this angle equals 1/855 (or for all practical purposes, 1/1000) of the radius. The angle corresponding to this part of the circumference is the dilec.

The approximate relation between the dilec and the orthodox measurement of angles by degrees (1/360 of the circle) and minutes (1/60 of a degree) may be seen from the following table.

Dilce	Degrees	Dilce	Minutes
1-00	6	0-01	4
2-00	12	0-02	7
3-00	18	0-03	11
4-00	24	0-04	14
5-00	30	0-05	18
6-00	36	0-06	22
7-00	42	0-07	25
8-00	48	0-08	29
9-00	54	0-09	32
10-00	60	0-10	36

SECRET

25X1A

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Values of dilce are spelled out and read as follows:

One dilec is spelled out reads	0-01, zero - zero - one
6 dilce are spelled out read	0-06, zero - zero - six
25 dilce are spelled out read	0-25, zero - twenty - five
130 dilce are spelled out read	1-30, one - thirty
1500 dilce are spelled out read	15-00, fifteen - zero - zero
1705 dilce are spelled out read	17-05, seventeen - zero - five.

Angles may be measured in dilce with the aid of the following instruments: The graded circle of the compass or the sighting device of trench mortars; the graded cross in binoculars; artillery protractors (on maps); movable machine-gun sight; or suitable make-shift devices.

Compass and mortar sight show a scaled circle, divided into large units of 1-00, and small units of 0-20 dilce; in addition, mortar sights have devices (fine scale) for measuring angles to an exactness of 0-01.

Soviet binoculars contain a scaled cross divided into large units of 0-10 dilce, and small units of 0-05.

On Czechoslovak binoculars, one unit of the vertical reticle represents 0-10 dilce, on the horizontal reticle 0-02 dilce.

The movable machine gun sight is graded in units of 0-01 dilce.

When using improvised implements for the measurement of angles, we must first determine the angle represented by them if held with outstretched arm (at a distance of 50 centimeters in front of the eye).

Example: One centimeter on a ruler (held 50 cm. in front of the eye) corresponds to an angle of 0-20, one milimeter corresponds to an angle of 0-02; the index finger covers an angle of 0-25 to 0-30; a bullet (caliber 7.62 mm) represents an angle of 0-15.

The length of the base of the segment corresponding to a dilec at any distance equals one thousandth of that distance:

At a distance of 1000 m. - 1 m.
At a distance of 500 m. - 0.5 m.
At a distance of 200 m. - 0.2 m.
At a distance of 1500 m. - 1.5 m., etc.

The length of the base corresponding to one dilec (1/1000 of the distance) at any given distance is called hodnota dilce (dilce value).

Use of dilce values permits simple and fast computations based on values of angles and distances, calculations that are essential in applied ballistics.

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Basic Terms /See Annex A, Fig., 1/

Draha strely (OVN) /trajectory/ is the curve traced by the projectile's center of gravity during its flight through space.

Uroven usti (U) /base of trajectory/ is the horizontal plane that is level with the center of the muzzle.

Vrchol drahy strely (V) /summit/ is the highest point of the trajectory.

Vyska vrcholu drahy strely (Zv) /maximum ordinate/ is the vertical distance between the summit and the base of the trajectory.

Oblouk vystupny (OV) is the ascending part of the trajectory up to the summit.

Oblouk sestupny (VN) is the descending part of the trajectory past the summit.

Tahla draha strely is that part of the ascending branch of the trajectory which is curbed only insignificantly (eg, in artillery, the lower group of angles up to 45 degrees).

Plocha draha strely /flat trajectory/ in small arms fire is a trajectory with a maximum ordinate of less than the height of a running man; in artillery, it is a trajectory with great muzzle velocity and angle of elevation.

Strma draha strely /high trajectory/ is a great curved trajectory (firing with the upper group of angles, i.e., above 45 degrees: Mortars, howitzers).

The flat trajectory makes it difficult to hit targets behind protective cover; the high trajectory facilitates the hitting of such targets. /See Annex A, Fig. 2/.

Derivace is the deviation of the trajectory from the plane of departure, caused by the rotation of the projectile. /See Annex A, Fig. 3/

Osa hlavne /axis of the bore/ is the imaginary line along the center of the barrel.

Namerna (Na) /line of elevation/ is the extension of the axis of the bore immediately prior to the firing of the piece. /See Annex A, Fig. 4/

Namer /angle of elevation/ is the angle between the line of elevation and the base of the trajectory.

Vystrelna is the prolongation of the axis of the bore at the moment when the projectile leaves the muzzle.

Spodni skupina uhlu are all angles of elevation which are smaller than the angle of elevation of the maximum range.

Vrchni skupina uhlu are all angles of elevation which are larger than the angle of elevation of the maximum range, but less than 90 degrees.

Skutecna pocatecni rychlost strely (Vo) /muzzle velocity/ is the speed of the projectile at the moment it leaves the muzzle.

Cil /target/ is the object, area, or animate being which we want to hit.

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Bod narazu (D) /point of impact/ is the point at which the projectile hits the terrain. If the point of impact is within the target, it is called zasah /hit/.

Vztazne body /reference points/ are immovable, clearly visible objects within a unit's field of fire, which we use for close identification of the target.

Zamerna is the imaginary line connecting the center of the notch in the rear sight /level with aiming edge/ and the top of the front sight.

Zamerna urciteho bodu is the imaginary line connecting the eye of the marksman, the center of the notch in the rear sight /level with the aiming edge/, and the top of the front sight with the aiming point /line of sight/.

Opticka zamerna /optical line of sight/ is the line passing from the eye through the appropriate point on the objective lens of the telescope.

Zamerny bod /aiming point/ is the point at which we aim. In marksmanship we select this point in such a way that the point of impact will be within the target.

Mirit /to sight/ means to adjust the position of the marksman in such a way that the extension of the line between rear and front sights passes through the eye.

Zamirit zbran /to aim a weapon/ means to line up the line of sight /optical line of sight/ in such a way that it passes from the eye over the sights of the weapon through the aiming point, i.e., to extend the line of sight to the aiming point.

Bodohledu /point of sight/ /on small arms/ is the point to which the line of sight pointed at the instance of firing.

Dalka cile (DC) /distance of target/ is the length of the line connecting the muzzle with the target. It is expressed in meters.

Dostrel /range/ is the distance from the muzzle to the point of impact.

Nejvetsi vodorovny dostrel /maximum range/ of a certain weapon is the largest topographic distance at which the weapon can fire.

Ucinny dostrel /maximum effective range/ of a certain weapon is the largest topographic distance at which the desired effect on a target can be obtained by fire from the weapon.

Under doba letu (T) /time of flight/ we understand the period of time between the instant the shot is fired and the instant the projectile arrives at the point of impact.

Ovladany prostor /dominated area/ is that part of the terrain within which a given weapon can be fired from one firing position effectively on all targets that might appear in that area. Its limits are determined by the effective range of the weapon.

Kryty prostor /concealed area/ is the area extending from behind an impenetrable obstacle, to the point of impact. /See Annex A, Fig. 5/

Zasazitelny prostor /unsafe area/ is that part of the concealed area within which a target can be hit. /See Annex A, Fig. 5/

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Hlùchy prostor [safe area] is that part of the concealed area within which a target connot be hit with a given weapon from a certain firing position. [See Annex A, Fig. 5]

The size of the safe area depends on the trajectory, the height of the obstacle, and the terrain.

Metny prostor [swept area] is that part of the terrain in which the descending branch of the trajectory does not exceed the height of the target. It depends on:
- the height of the target (the higher the target, the larger the area),
- the flatness of the trajectory (the flatter the trajectory, the larger the area),
- the topography of the terrain at the location of the target,
- the angle of impact [See Annex A, Fig. 6].

The metny prostor is smaller on a forward slope (declining toward the weapon), and is larger on a reverse slope (if the angle of impact is larger than the angle of the slope); the metny prostor is smaller when we fire down a decline, larger when we fire up an incline.

Precision and Accuracy of Fire

Firing is precise and accurate if the hits are on the target and are grouped in such a way that they do not exceed the permissible dispersion. [See Annex A, Fig. 7a].

Firing is precise, but not accurate, if the hits are grouped within the permissible dispersion, but outside the target. This type of firing can always be easily corrected to accuracy either by adjustment of the front sight, by a change of aiming point, or by improved aiming technique, depending on the cause of the inaccuracy [See Annex A, Fig. 7b].

Firing is not precise, but accurate, if the core of the grouped hits is on the target, but the grouping exceeds the permissible dispersion [See Annex A, Fig. 7c].

Firing is neither precise nor accurate if the core of the grouped hits is outside the target, and the grouping exceeds the permissible dispersion [See Annex A, Fig. 7d].

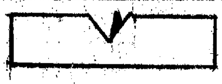
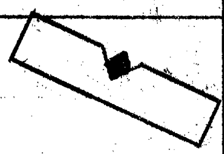
Errors in Aiming and Sighting

Aiming and sighting are influenced by two factors: the marksman and the light. Both these factors might cause errors in aiming and sighting.

Influence of the marksman

In aiming and sighting, the marskman might make one of the following mistakes:

Mistake		Effect of mistake on position of muzzle	Result of mistake
	high front sight	Muzzle is being elevated	Point of impact above aiming point
	low front sight	Muzzle is being depressed	Point of impact below aiming point

Mistake		Effect of mistake on position of muzzle	Result of mistake
	front sight inclined to right	Muzzle moved to the right	Point of impact to the right of aiming point
	front sight inclined to left	Muzzle moved to the left	Point of impact to the left of aiming point
	rifle canted right (or left)	Muzzle moved down and to the right (or left)	Point of impact right below (or left below) aiming point

Influence of Light

Front sight in sunlight from above appears higher.

Insufficiently lighted front sight appears lower, as it does also when we fire with the sun in our eyes.

Front sight lighted with sun light from the right (or left) appears inclined to the right (or left).

The marksman believes that he is sighting correctly, but actually he sights: in the first case, with a low front sight; in the second case, with a high front sight; in the third case with a front sight inclined to the left (or right).

It is important to remember that the marksman usually errs in the direction of the shadow.

Influence of the Weather

The following factors also influence the prevision of fire: changes in the temperature, changes in the atmospheric pressure, changes in the direction of the wind. The following is a table of the corrections necessary to overcome the above influences:

[redacted]

Adjustments for Air Influences and Deviations in 7.62 mm LMG, Rifle and Carbine Firing

Distance in Meters	Adjustments in Range			Adjustments in Height			Azimuth Adjustments Meters and Degrees			
	Change in Air Temp of 10°	Change in Air Pressure of 10 mm	Longitudinal Wind 10 m/sec.	Change in Air Temp of 10°	Change in Air Pressure of 10 mm	Logitudinal Wind 10 m/sec.	Cross Wind 4 m/sec. blowing at less than 90° Angle		Deviations	
							M	De	M	De
100	2	-	-	-	-	-	0.03	0.2	-	-
200	4	-	-	0.01	-	-	0.09	0.4	0.01	-
300	6	1	1	0.02	-	-	0.20	0.7	0.02	0.1
400	8	1	2	0.04	-	0.01	0.40	1.0	0.04	0.1
500	10	2	3	0.07	0.01	0.02	0.68	1.4	0.07	0.1
600	13	3	4	0.12	0.03	0.04	1.0	1.8	0.12	0.2
700	16	4	6	0.21	0.05	0.08	1.5	2.2	0.19	0.2
800	19	5	8	0.35	0.09	0.15	2.1	2.7	0.29	0.3
900	22	6	11	0.54	0.14	0.26	2.8	3.2	0.43	0.5
1000	26	7	14	0.80	0.20	0.42	3.6	3.6	0.62	0.6

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Adjustments for Air Influences and Deviation in Firing 7.92 mm Ball Cartridge, Model 47, with MG, Model 37

Distance	Adjustments in Range			Adjustments in Height			Azimuth Adjustments			
	Change in Air Temp 10°	Change in Air Pressure of 10 mm	Longitudinal Wind of 10 m/sec.	Change in Air Temp 10°	Change in Air Pressure of 10 mm	Logitudinal Wind of 10 m/sec.	Cross Wind 4 m/sec.		Deviations	
M	M	M	M	M	M	M	M	Dc	M	Dc
100	3	1	1	0.003	0.001	0.001	0.4	0.4	-	-
200	5	1	2	0.01	0.002	0.004	0.12	0.6	-	-
300	7	2	3	0.02	0.006	0.009	0.24	0.8	-	-
400	10	2	4	0.05	0.01	0.02	0.40	1.0	-	-
500	12	3	5	0.08	0.02	0.04	0.65	1.3	-	-
600	14	3	6	0.14	0.03	0.06	0.96	1.6	-	-
700	17	4	8	0.22	0.05	0.10	1.3	1.8	-	-
800	19	4	9	0.32	0.07	0.15	1.6	2.0	0.2	-
900	21	5	11	0.44	0.10	0.23	2.1	2.3	0.4	-
1000	23	6	13	0.60	0.16	0.34	2.5	2.5	0.6	1

Remark: This table also holds true for MG, Model 26, and Rifle, Model 24, in firing 7.92 mm ball cartridges, Model 47.

[redacted]

Adjustments for Air Influences and Deviations in Firing 9 mm Cartridge, Model 48, from a 9 mm SMG, Models 23 and 25

Distance in Meters	Adjustments in Height in cm		Azimuth Adjustments, in cms	
	Change in Air Temp of 10°c	Longitudinal Wind of 10 m/sec.	Cross Wind blowing at 90° Angle	Deviations
100	1	1	15	Without Sight
200	4	7	65	
300	15	18	165	
400	39	41	430	

[redacted]

Ballistic Data

When the level of sight is raised in firing the 7.92 mm ball cartridge, Model 47, from the MG, Model 37, the following increases result:

Distance in Meters	100	200	300	400	500	600	700	800	900	1000	1100
Sighting	Increases										
2	0.1	0	0.3	0.8							
3	0.2	0.2	0	0.4	1.2						
4	0.3	0.4	0.3	0	0.8	1.7					
5	0.4	0.6	0.6	0.4	0	1.1	2.8				
6	0.6	0.9	1.1	1.0	0.7	0	1.3	3.1			
7	0.8	1.3	1.7	1.8	1.8	1.1	0	1.6	3.6		
8	1.0	1.7	2.3	2.7	2.9	2.3	1.4	0	1.8	3.9	
9	1.2	2.1	2.9	3.5	4.0	3.5	2.8	1.6	0	2.5	5.4
10	1.4	2.5	3.5	4.4	5.1	4.8	4.4	3.4	1.8	0	3.2

Remark: This table is also used for MG, Model 26, and Rifle, Model 24, in firing 7.92 mm ball cartridge Model 47.

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Distance in Meters	50	100	150	200	250	300	350	400	450	500
Sight Distance	Increase in cm									
1	0.06	0	0.25	0.70						
2	0.26	0.39	0.32	0	0.59	1.51				
3	0.58	1.02	1.23	1.17	0.78	0	1.19	3.05		
4	1.05	1.95	2.59	2.94	2.91	2.44	1.48	0	2.18	5.16

Information Data on Infantry Weapons

Weapons	Caliber, mm	Number of Grooves (Rifling)	Sight Distance, m	Velocity, m/secs. Light Cartridge / Heavy Cartridge	Weight of Cartridge, gm Light Cartridge / Heavy Cartridge	Weight, filled, gm
HMG (Maxim)	7.62	4	911	865 / 800	9.6 / 11.6	3.25 / 3.10
HMG (Gorjunovova)	7.62	4	855	865 / 800	9.6 / 11.6	3.25 / 3.10
LMG - DP	7.62	4	616	840	9.6	3.25
Rifle, Model 1891/30	7.62	4	616	865	9.6	3.25
SMG, Model 1941	7.62	4	365	500	5.5	0.6
SMG, Model 1943	7.62	4	352	510	5.5	0.6
Pistol, Model 1933	7.62	4	156	440	5.5	0.6
MG, Model 37	7.92	4	830	775	11.55	3.-
MG Model 26	7.92	4	590 / 568	775	11.55	3.-
Rifle, Model 24	7.92	4	504.9	765	11.55	3.-
SMGs, Models 23 and 25	9.-	6	270	450	6.4	0.38 / 0.40

25X1A

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Table of Penetration
7.92mm Ball Cartridge, Model 23

Objects	Distance of objects from muzzle of barrel		
	100 m	200 m	300 m
	Depth of Penetration		
	Ball cartridge model 23		
	Cm		
Soft wood	135	113	97
Hard wood	62	53	45
Dry sand	40	29	20
Wet sand	35	28	20
Arable soil	40	24	20
Clay	35	35	26
Sand with gravel	20	18	15
Brick masonry	16	--	--
Hand iron plate	0.60	0.49	0.43

Dimensions of field shapes (forms)

Types of field shapes	height	weight
	in cm	
Head	25	25
Hidden lying figure	30	25
Not hidden lying figure	50	50
Kneeling figure	100	50
Running figure - forward	150	50
Running figure - to the flank	150	45
Standing figure	170	50

Remark: The maximum width of the figure is measured.

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Finding the Range

The basic method of finding the range in battle is by estimation. Other helpful methods are: By stepping off the distance, with the aid of angle values or stationary objects (targets) and, by measuring the distance with the aid of maps.

Finding the Range by Estimation

We estimate the range by the following methods:

1. By retaining information on a certain sector of the terrain in one's mind.

2. By the clarity and appearance of the object or target.

3. Triangulation.

4. With the aid of angle values of stationary objects or targets.

The method shown under paragraph 1, above, is useful only on terrain that is level. One adept at estimating distance should have no difficulty in estimating ranges of 100 to 400 m. The following precepts should be kept in mind: (a) The greater the area the closer it appears to be in perspective. (b) Depressions, ravines, gorges, streams, etc., make it difficult in estimating the range. Objects that are not clearly visible appear to be close.

In estimating range in relation to clarity and the size of the object one has to allow for the sharpness of the object, its size, its color contrast, light contrast, and the transparency of the air. For example:

(a) At great distances small objects such as bushes, stones, little mounds, and individual figures seem further away than large objects such as forests, mountains, communities, and towns.

(b) Bright colored objects (white, orange, etc.) seem closer than dark colored objects (blue, brown, etc.).

(c) An object appears to be approaching the observer when seen against a uniformly colored background such as represented by a plowed or snow-covered field, meadow, etc.

(d) On dull, rainy, cloudy, or foggy days distances are overestimated while on bright sunny days they are underestimated.

(e) In mountainous terrain all visible objects appear closer.

Notes: We arrive at the approximate distance depending on the clarity of the target, for example:

At 1500 m. and further, a group of marching men in close formation looks like a dark spot or figure. Here and there one sees reflections of insignia or other objects worn by the men. One can notice movement.

At 900-1000 m. we distinguish units marching three abreast and men on horses. Images of live figures (men and animals) are not clear and it is hard to recognize them. One can distinguish stained or spotted windows on buildings, outlines of trees and the lower parts of tree trunks. One can see large posts, thick props (supports), and road signs on telegraph poles.

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At 700-800 m. one can distinguish the whole outline of a live target and differentiate between horses and troops. One can also recognize chimneys and dormer windows, large branches on trees, small poles, supports, and props.

At 500-600 m. one can distinctly see the outline of live figures, the movement of arms and legs, as well as of horses and helmets. It is possible to recognize details of a building such as the veranda, doors, windows, as well as the yard. One can see large tree branches, and fence posts are apparent.

At 400 m. one can recognize live figures as well as the outline of whatever they are wearing such as footgear, clothing and head coverings. Windows as well as branches of trees are visible. One can recognize the outlines of heavy infantry weapons, such as the machine guns, mortars, and antitank guns.

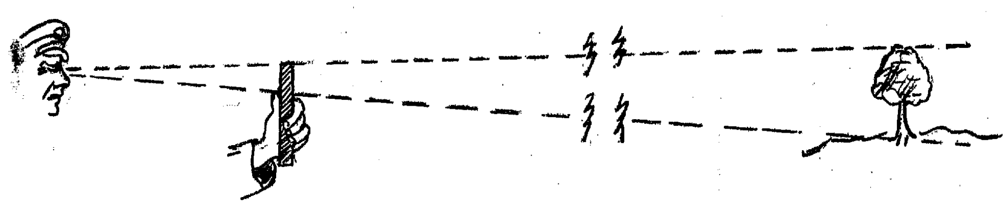
At 300 m. one can recognize the face of a person and the various shades of clothing the person is wearing. Details in connection with cornices, door ledges and gutter piping are apparent. It is possible to differentiate among the various types of trees such as the fir, pine, birch, and basswood. Infantry small arms, such as rifles and submachine guns, are recognizable.

At 200 m. one can distinguish the physical features of a person and the equipment he wears, such as the belt, shoulder harness, and head covering. It is possible to distinguish broken windows and the framework of a building. Leaves on trees and the wire used on a fence are visible.

At 100 m. it is possible to distinguish parts of the face, eyes, nose, mouth and it is possible to see the hands and details of equipment and weapons. One can distinguish individual bricks, etchings, and plastic ornaments as well as broken plaster in buildings. One can recognize the shape and color of leaves and the bark of the tree trunk. One can see individual parts of infantry weapons.

Estimating Distance by Triangulation

At a distance of 50 cm. from the eye we hold upright any convenient object such as a pencil, match, blade of grass, etc., and line it up with the object. Then, without moving, we look with the other eye and obtain a new sighting.



Lines of sight, originating with the two eyes, cross at the sighting instrument and appear as shoulders of two spherical angles. The positions of the two eyes are connected by a straight line and the terrain points at which the line of sight end are also connected and two right triangles are thus produced. The distance between the eyes (about 65 mm.) and that from the eyes to the sighting instrument can be expressed as 1:8 (actually 1:7.7). A similar situation exists in regard to the sighting instrument and the two terrain points at which the lines of sight end.

[redacted]

The most important assumption for estimating distance by the horizontal method is dependent on the spacing of terrain points. We can accomplish this by comparison to windows in the area of the target, widths of roads, houses, distances between telegraph poles, etc.

For example, should we estimate the distance between the two terrain points at 80 m., the wanted distance is 8 times larger, or 640 m.

Accuracy of the estimate is dependent on the accuracy of the target terrain width, according to how well we estimate the distance, and on how closely to 50 cm. away the sighting instrument is held.

Finding the Distance According to the Angle Values of Stationary Objects.

To find the distance with this method it is necessary to accurately know the width or height of the object or target. We measure the angle value of the object and then arrive at the distance by the use of the following formula.

$$D = \frac{V.1000}{U}$$

where $D=$ distance
$V=$ width or height of object
$U=$ angle value of object

Example: A tree, 20 m. high, appears to be 12 mm. high on a ruler held 50 cm. from the eye. That represents 0-25 angle value (dilce) and we can now obtain the distance to the tree.

$$D = \frac{20.1000}{25} = \frac{20.000}{25} = 800 \text{ m.}$$

Errors in Estimating Distances and Their Corrections

Various circumstances have a bearing on the attainment of the correct estimate. An underestimation of distance occurs especially under the following conditions:

(a) In combat

(b) On plains, snow fields, extensive meadows, water

(c) In early morning and early evening. The sun, in back of the observer, sharply illumines objects which then seem close.

(d) When the background is uniform (target appears larger).

(e) When looking up a slope.

(f) During rain or in a snow storm (target appears larger).

(g) When there is an area (depression) between the observer and the target into which the observer cannot see.

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An overestimation of distances occurs under the following conditions:

(a) When in a prone or kneeling position.

(b) When the target cannot be seen clearly.

(c) When dark colored terrain (coniferous forests, valleys) intervene between the observer and the target.

(d) When the sun shines directly into the observer's eyes (eyes squint).

(e) During wind, fog, cloudiness.

(f) When looking down a slope.

(g) When looking directly down a road, in a narrow valley.

So that the errors would not be large in estimating distances we use two or more methods. For the actual distance we take the average arrived at by estimates acquired the following ways:

By Pacing Off Distances

When pacing distances we count the number of double paces. In arriving at the distance covered in one double pace we use the following method: A distance of at least 200 m. is measured off by means of a tape and on level ground. This distance is then paced two or three times and the paces taken by the individual are recorded.

If on three separate occasions we count 130, 131 and 129 double paces, respectively, the average of 130 is taken as standard. Since 130 double paces were required to cover 200 m. one double pace is found to be equivalent to 1.54 m.

Example - By measuring a distance by paces it was found to be 65 double paces long. The paced distance was therefore: 65 x 1.54 m= 100 m.

By Orientation in the Field. How Can One Tell the Direction of North?

Bark of trees. Usually the bark of the tree on the northwest side is cracked, thicker and is covered with lichens because cold winds and rains come from that direction and the tree must protect itself. Lichens grow in damp areas.

On tree stumps the year rings are closer together on the north side than on the south. This is so because the cold winds blow from the north and the tree grows less on that side than it does on the other.

According to the sun. The sun rises in the morning at 0600 approximately in the east, at 0900 it is in the southeast, at 1200 it is in the south, at 1500 it is in the southwest and at 1800 it is in the west. Vineyards usually are planted on a slope, facing south or southeast.

25X1A

[redacted]

According to the stars. It is simpler to find true north by means of the North or Polar Star for it does not vary its position throughout the year. Locating true north is accomplished in the following manner: An imaginary line is extended from the "rear wheels" of the stars forming the "Large Wagon" (Ursa Major) and on this imaginary line we quintuple the distance between the wheels of the "Large Wagon". Polaris is the last star in the wagon tongue of the star group "Small Wagon" (Ursa Minor).

Christian churches usually have the main altar on the east side.

With the aid of a watch. The watch is placed in a horizontal position in such a way that the hour hand points at the sun. The angle formed by the hour hand and the number 12 is then bisected. For example, at 0800 in the morning the half point will fall on the number 10, at 1600 in the afternoon the half point will fall on number 2. Thus in the forenoon we halve the angle to the right of the small hours hand and in the afternoon to the left of the small hour hand. When the imaginary line is drawn from the center of the watch to the half point and is projected out, it will point directly south.

ANNEX A: Illustrations of Basic Terms, Figures 1 - 7.

Annex A

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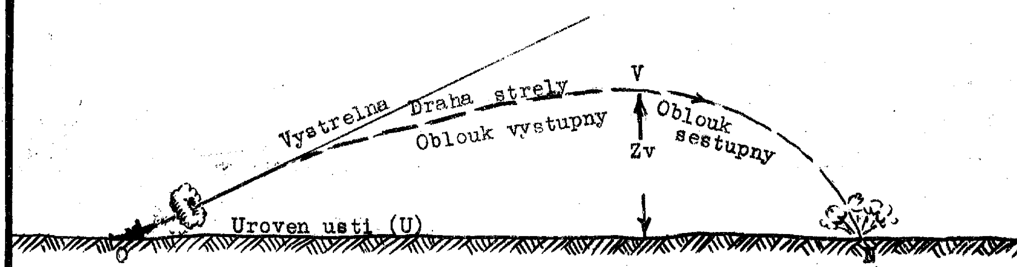


Fig 1 - Basic terms

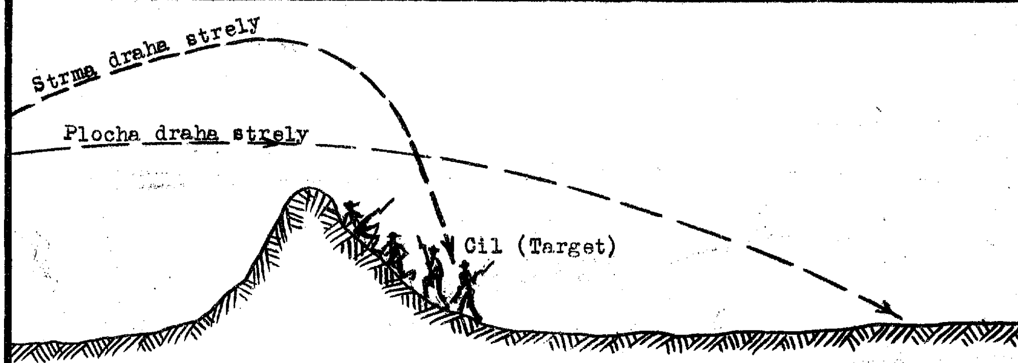


Fig 2 - Possibility of hits on protected targets

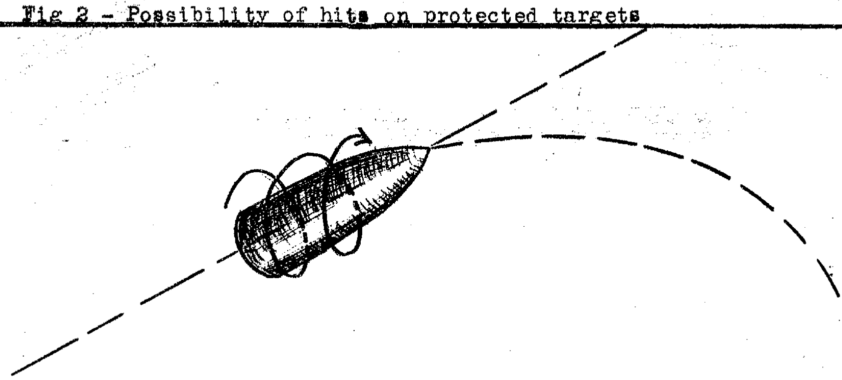
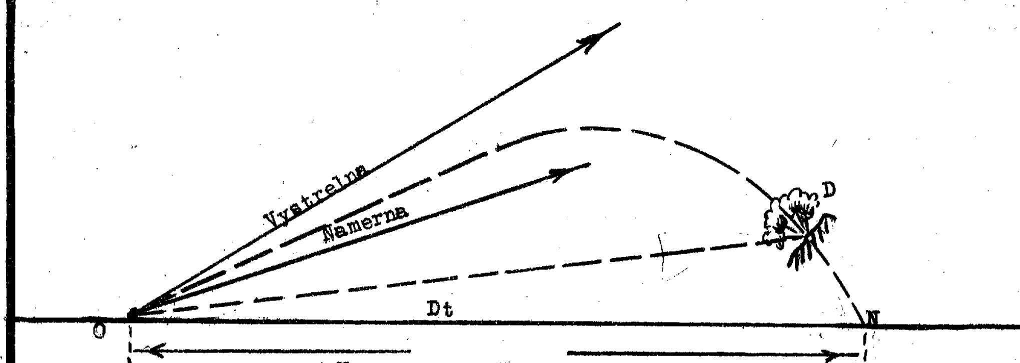


Fig 3 - Rotation of projectile



Source: (DS-519)
Date of Info: 1952

Fig 4

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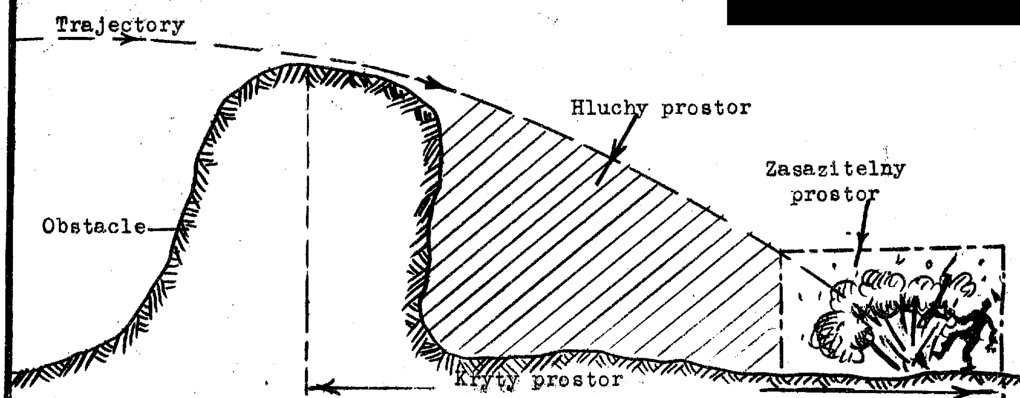

Fig 5 - Concealed, unsafe, and safe areas.

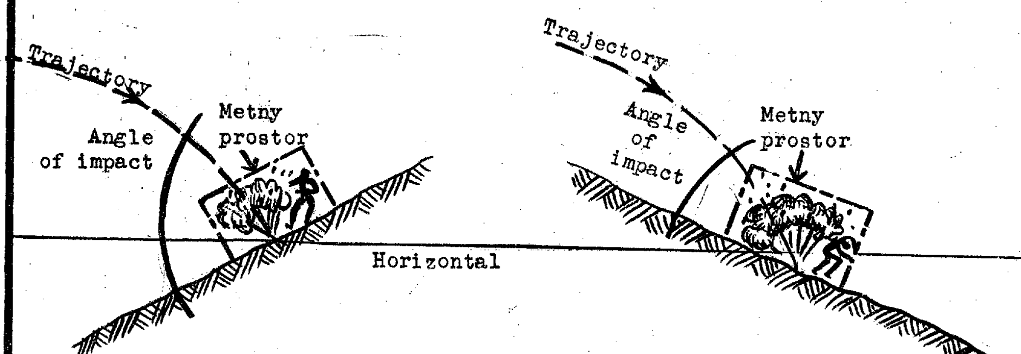

Fig 6 - Dependence of swept area on angle of impact

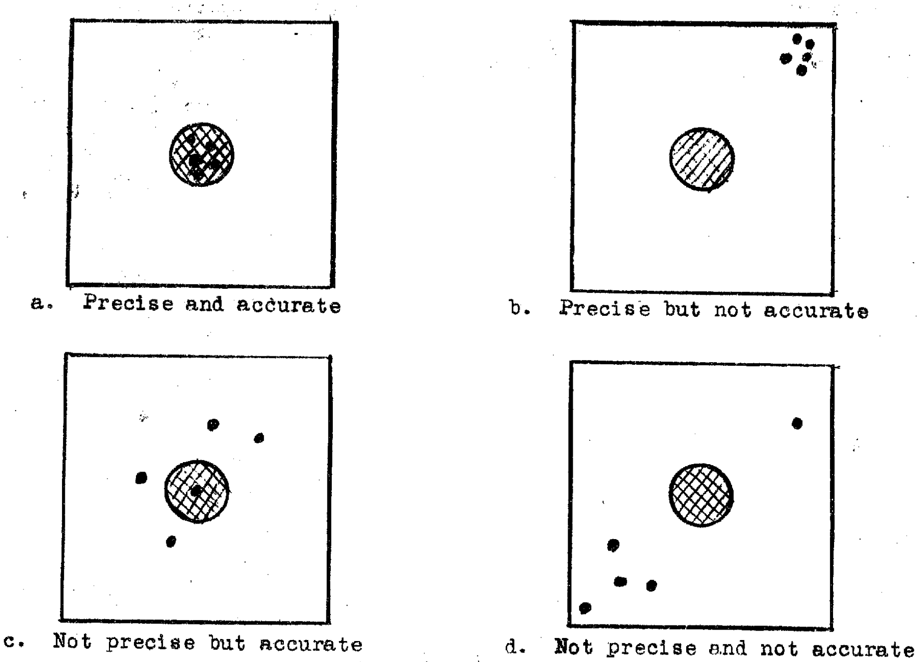

Fig 7